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Biologic and Economic Aspects of Spring and Fall Breeding of Sheep

Bulletin 562 MAY 1968

West Virginia University
Agricultural Experiment Station

AUTHORS

A. L. Barr is Associate Agricultural Economist; C. J. Cunningham is Animal Husbandman in charge of Reymann Memorial Farms; J. O. Harper was formerly Graduate Student; and E. K. Inskeep is Assistant Animal Scientist.

ACKNOWLEDGMENTS

The authors wish to acknowledge contributions of: Dr. James A. Welch, who assisted in the development and initiation of the project; Dr. J. O. Heishman, Veterinarian, who assisted throughout the project; Mr. Benjamin Wamsley, Jr., Dr. James L. McBee, Jr., and the county agricultural agents who assisted in the weighing and grading of lambs; and Mr. Jerry Andrick and Mr. E. J. Harner, Jr., who assisted in programming the statistical analyses of the data.

West Virginia University
Agricultural Experiment Station
College of Agriculture and Forestry
A. H. VanLandingham, Director
Morgantown, West Virginia

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Summary and Conclusions

This study was designed to determine if a flock of crossbrec sheep under normal farm management practices could be successfully bred in the spring and if such a practice would be economically feasible. Lambs would then be born in the fal and marketed at higher prices in early spring.

A flock of 144 grade ewes was available at the Reymann Memorial Farms. Eighty-nine of these ewes were randomly allotted to one flock and exposed to Dorset and Hampshire rams in the spring. The remaining 55 ewes were exposed to the same rams during the fall breeding season and served as a contro flock.

Records were kept for three years (1963 to 1966) of the occurrence of estrus, conception, lambing percentages, birth weights of lambs, livability of lambs at birth and at 30 days weights of lambs at 150 days, wool weights and prices, grain and hay consumption by the ewes and lambs, anthelmintics required, and prices received for the lambs.

Ewes exposed to rams in the fall were superior to spring exposed ewes in (1) occurrence of estrus (96 to 81 per cent) (2) lambing percentage (183 to 154 per cent), (3) birth weights of lambs (10.0 to 9.4 pounds), (4) livability of lambs at birth (99.0 to 94.0 per cent), (5) average daily gain of lambs (0.53 to 0.48 pounds), and (6) wool weight (7.7 to 7.3 pounds). There were no significant differences in conception rates or livability of lambs at 30 days between the two flocks.

The average price received for lambs from the spring-breeding flock was more than 5 cents per pound greater than fo lambs from the fall-breeding flock. The difference was more than enough to offset the faster rate of gain of lambs from the fall-breeding flock so income per lamb was about $3.00 higher in the spring-breeding flock. However, the number of lambs available for sale per ewe exposed was 1.45 in the fall-breeding flock bu only 0.96 in the spring-breeding flock. Thus, the income from lambs per ewe exposed averaged $6.56 more in the fall-breeding flock.

The spring-breeding flock also required 133 pounds more grain costing approximately $4.13 more per ewe exposed. The combination of more lambs and lower feed costs resulted in $10.70 more net income per ewe exposed in the fall-bred flock.

Biologic and Economic Aspects of Spring and Fall Breeding of Sheep

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A. L. Barr, C. J. Cunningham, J. O. Harper and E. K. Inskeep[1]

THE NUMBER OF SHEEP on farms in West Virginia has declined sharply since 1950. This decline has continued even though lamb and wool prices have been quite favorable and sheep production is a highly profitable livestock enterprise on West Virginia farms (Barr et al. 1966). Difficulties encountered in the control of dogs and internal parasites, insufficient pastures during summer drought periods, and the cold, unfavorable weather often experienced during the winter lambing period are some of the factors that have contributed to the decline in sheep numbers in the State.

If ewes are bred successfully in May and June, and lamb in October and November, some of these difficulties can be eliminated. The lambs are born during the mild fall weather and reach market weight in April and May. They can be marketed before hot weather, internal parasites, or dormant pastures retard their growth.

A study of the biologic and economic aspects of fall lambing in West Virginia was initiated in 1963. The experiment was conducted at the Reymann Memorial Farms at Wardensville. A flock of 144 grade ewes of known ancestry and performance and sired by Corriedale, Dorset, Hampshire and Suffolk rams was studied. Eighty-nine of these ewes were selected at random within age groups to be bred in the spring. The other 55 ewes were bred in the fall and served as a control group. Dorset and Hampshire rams were used in both breeding groups throughout the experiment with new rams being acquired annually. The two flocks of sheep were maintained under farm management practices typical of those used by better sheep farmers in the State. In this study, no attempt was made to influence the occurrence of estrus through either management practices or the use of medication.

[1] Research reported herein was done under Hatch Project 171, Alternative Management Systems for Lamb Production.

Each flock was exposed to the rams for a seven-week period (approximately three estrual cycles) beginning in early May for the spring-breeding group and in early September for the fall-breeding group. During the breeding season two rams of the same breed were alternated at two-week intervals between lots of 10 to 25 ewes. A marking crayon on the brisket of the rams was used to facilitate checking for estrus during the breeding season. Colors were changed every two weeks so re-occurrence of estrus could be determined. Weekly observations were made during the breeding season and the identification of ewes marked by rams during the previous week was recorded.

The two flocks were wintered separately. The ration fed each group consisted of alfalfa hay and a grain mixture of ½ corn and ½ oats. The feeding of grain was regulated so as to maintain the body condition of the ewe flock. Dry ewes from the spring-breeding group were wintered separately on a legume hay without grain. A phenothiazine-salt mixture offered free-choice and thiabendazole as a drench were used to control parasites.

Data collected on the two flocks over a three-year period (1963 to 1966) included:

(1) Ewes showing estrus during the breeding season.
(2) Ewes showing more than one estrus during the breeding season.
(3) Ewes conceiving of ewes showing estrus.
(4) Number of lambs born and whether alive or dead at birth.
(5) Sex and type of birth.
(6) Birth weights of lambs.
(7) Number of lambs living to one month of age.
(8) Age and weight of lambs at marketing.
(9) Prices received for lambs at marketing.
(10) Fleece weights of the ewes.
(11) Weight of hay and grain fed to each flock of ewes.
(12) Pounds of creep feed eaten by the lambs.
(13) Frequency of administration and cost of drugs needed to control internal parasites.

Data on each biologic trait were analyzed by the method of least squares, for differences due to season, year, breed of ram, type of birth, sex, type of rearing, and interactions of these variables. Statistical means presented in the following discussion are the adjusted means obtained from the least squares analysis. Differences between three or more groups per classification (e.g., years) were determined by multiple range test (Kramer, 1956). Differences having a probability of greater than 5 per cent of being due to chance were not considered to be significant.

Results and Discussion

Biologic Aspects

Occurrence of estrus. Estrus occurred in 89 per cent of all ewes studied as determined by paint marks from the rams. Only 81 per cent of the ewes in the spring-breeding flock exhibited estrus, while over 96 per cent of the ewes in the fall-breeding flock were marked ($P < 0.01$, Table 1). In this study no differences were detected due to breed of ram or year.

TABLE 1

Occurrence of Estrus, Conception Rates, and Lambing Percentage by Breeding Season[a]

Item	Season of Breeding		Overall Mean
	Spring	Fall	
Occurrence of estrus (per cent)	81.1^{l}	96.7^{m}	89.1
Conception at first service[b]	74.9	72.8	73.9
Conception at all services[b]	84.2	91.1	87.7
Lambing percentage[c]	154^{n}	183^{o}	168

[a] Season means within a row followed by different superscripts differ significantly ($P < 0.01$).

[b] Per cent of ewes showing estrus that gave birth to a lamb.

[c] Lambs born of ewes lambing.

There was, however, a significant interaction ($P < 0.01$) between the breed of ram and season of breeding in the occurrence of estrus. The occurrence of estrus was 22.2 percentage points greater for ewes exposed to Hampshire rams in the fall (99.9 per cent) than for ewes exposed to the same rams in the spring (77.7 per cent), but the occurrence of estrus was only 8.2 percentage points greater (93.4 to 85.2 per cent) for ewes exposed to Dorset rams in the fall than for ewes exposed to the same rams in the spring. These results suggest that the Dorset rams may have shown greater libido in the spring than the Hampshires but differences between breeds during the spring-breeding season were not significant.

Conception rate. A total of 87.7 per cent of those ewes showing estrus conceived (Table 1). Although the overall conception rate was higher in the fall-breeding flock than in the spring-breeding flock, 91.1 to 84.2 per cent, this difference was not statistically significant. Conception rate at first service averaged approximately 74 per cent and did not vary with the season of breeding. Similar results were observed in Australian Merino ewes by Watson and Radford (1966). It appeared in both of these studies that a higher percentage of the fall-exposed ewes may have returned to estrus and remated after failure to conceive at first service. If, however, the spring-exposed ewes began to cycle only after introduction of the ram (Schinckel, 1954), they would have shown estrus one time less than the fall-exposed ewes during the seven-week breeding period.

Lambing percentage. The number of lambs born as a per cent of ewes lambing is dependent upon the rate of ovulation, upon the fertility of the ova produced and of the ram, and upon survival rate of embryos. The lambing percentage was higher ($P < 0.01$) for ewes bred in the fall than for ewes bred in the spring (183 to 154 per cent). It also was higher ($P < 0.05$) for ewes bred by Dorset rams than for ewes bred by Hampshire rams. The latter result indicates that either the Dorset rams were more fertile than the Hampshire rams, that survival rate of embryos was higher in Dorset-bred ewes, or that by chance the ewes allotted to the Dorset rams had a higher incidence of multiple ovulations.

TABLE 2

Birth Weight, Livability at Birth and at 30 Days and Average Daily Gain of Lambs by Breeding Season[a]

Item	Season of Breeding		Overall Mean
	Spring	Fall	
Birth weight (lbs.)	9.1^{l}	10.0^{m}	9.7
Per cent lambs born alive	94.0^{b}	99.0^{c}	96.5
Per cent livability at 30 days of lambs born	87.5	93.1	90.3
Per cent livability at 30 days of lambs born alive	92.9	93.9	93.4
Average daily gain to 150 days (lbs.) .	$.48^{l}$	$.53^{m}$	.50

[a] Season means within a row followed by different superscripts differ significantly (b-c, $P < 0.05$; l-m, $P < 0.01$).

Birth weight. The average birth weight for all lambs was 9.7 pounds (Table 2). The average weight of lambs born to the fall-bred ewes (10.0 pounds) was higher ($P < 0.05$) than that of lambs born to spring-bred ewes (9.4 pounds). This difference was probably due to the higher temperatures during the summer gestation period (Shelton, 1964 a, b).

Differences in birth weight also existed between breeds ($P < 0.01$), sexes ($P < 0.01$), types of birth (single vs. multiple; $P < 0.01$), and years ($P < 0.05$). At birth, Hampshire-sired lambs averaged 0.8 pounds more than Dorset-sired lambs. Male lambs averaged 0.4 pounds heavier than female lambs. Single-born lambs weighed 1.8 pounds more than multiple-born lambs. Lambs born in the second year of the study averaged 0.6 pounds more than lambs born in the first year and 0.8 pounds more than lambs born in the third year. These differences were not unexpected and were in agreement with results obtained in earlier studies including those of Cunningham **et. al.** (1965, 1966).

Livability at birth. An average of 3.5 per cent of all lambs born were dead at birth (when first observed). Livability at birth was significantly greater for lambs born from fall breeding than for lambs born from spring breeding. Ninety-nine per cent of the lambs born in the spring and 94 per cent of the lambs born in the fall were alive at birth. There were no differences in the per cent of lambs alive due to breed, sex, type of birth or year.

There was a significant interaction of season and sex affecting livability at birth. The livability of spring-born females exceeded that of fall-born females by 10.8 per cent but the livability of spring-born males exceeded that of fall-born males by only 1.7 per cent. Livability at birth seemed to be positively correlated with birth weight as was reported earlier by Shelton (1964 a). Gestation during the summer months apparently tended to decrease lamb birth weight, and, thereby, decrease vigor and livability. Male lambs, being heavier at birth, were apparently more able to withstand the greater stress of the spring breeding program.

Livability to 30 days. Of all lambs born, 6.2 per cent died between birth and the age of 30 days. Although a slightly higher proportion of the lambs from the fall-breeding flock reached an age of 30 days, the difference was not significant. No differences in livability to 30 days due to breed, sex, type of birth or year were detected.

Average daily gain. The average daily gain of all lambs to 150 days of age was 0.50 pounds. The adjusted average daily gains were 0.48 pounds for lambs born from spring breeding and 0.52 pounds for lambs born from fall breeding ($P < 0.01$). Lambs from the Hampshire-bred ewes gained an average of only 0.02 pounds per day more than lambs from the Dorset-bred ewes ($P < 0.05$). Male lambs outgained females by 0.04 pounds per day ($P < 0.01$) and those reared as singles surpassed twins by the same margin ($P < 0.01$).

Wool weight. The average fleece weight was 7.3 pounds for ewes bred in the spring and 7.7 pounds for ewes bred in the fall ($P < 0.05$). The number of lambs born or raised also had an effect on fleece weight. The average fleece weight for ewes having no lambs was 8.0 pounds, for ewes having one lamb it was 7.4 pounds, and for ewes having two or more lambs, 7.1 pounds. The differences were statistically significant between ewes having zero and one lamb ($P < 0.05$), and zero and two lambs ($P < 0.01$), but the difference in fleece weight between ewes having one and two lambs was not significant.

Economic Aspects

Records of costs and income were kept for items which differed between the two systems. Cost items which differed were quantities of hay, grain and anthelmintics. Income items which differed were numbers, weights and prices for lambs and the weight and price of wool.

Costs. Cost items which differed for the two flocks are presented in Tables 3 and 4. Ewe depreciation, ram costs, salt and mineral consumption and shearing costs per ewe did not differ for the two flocks. Although pasture requirements were probably higher for the fall-breeding flock because the lambs from that flock were on pasture during much of the summer, no attempts were made to measure this difference or differences in labor requirements.

a. **Grain requirements.** The quantity of grain fed to the ewe flock was adequate to maintain the body condition of the flock, as determined by the flock manager, and to prevent pregnancy disease. Ewes in the spring-breeding flock were fed an average of 72.5 pounds of grain per head per year and ewes in the fall group were fed 53.4 pounds. Lambs in the spring-breeding

TABLE 3

Input Items and Costs for the Spring-Breeding Flock[a]

Item	Year 1	Year 2	Year 3	Average
Grain consumed per ewe (lbs.)	65.3	67.2	85.9	72.5
Creep grain consumed per lamb sold (lbs.)	138.6	119.0	150.0	134.1
Total grain consumed per ewe exposed (lbs.)[b]	197.0	200.5	207.4	201.2
Cost of grain consumed per ewe exposed[c]	$6.11	$6.22	$6.43	$6.24
Hay fed per ewe exposed (lbs.)	418	357	284	355
Cost of hay per ewe exposed[d]	$8.36	$7.14	$5.68	$7.10
Drenching cost per ewe exposed[e]	$0.53	$0.53	$0.53	$0.53
Total of itemized costs per ewe	$15.00	$13.89	$12.64	$13.87

[a] Includes only those costs which differed between the two systems.

[b] Includes grain fed to the ewes plus grain fed to lambs per ewe exposed.

[c] Grain cost was 3.1 cents per pound.

[d] Hay cost was 2 cents per pound.

[e] Drenching cost was 17.5 cents per dose. Each ewe was given 3 doses of thiabendazole per year.

TABLE 4

Input Items and Costs for the Fall-Breeding Flock[a]

Item	Year 1	Year 2	Year 3	Average
Grain consumed per ewe (lbs.)	41.2	74.7	47.2	53.1
Creep grain consumed per lamb sold (lbs.)	11.6	3.6	15.2	10.1
Total grain consumed per ewe exposed (lbs.)[b]	58.0	79.9	68.3	68.0
Cost of grain consumed per ewe exposed[c]	$1.80	$2.48	$2.12	$2.11
Hay fed per ewe exposed (lbs.)	339	386	363	361
Cost of hay per ewe exposed[d]	$6.78	$7.72	$7.26	$7.22
Drenching cost per ewe exposed[e]	$0.67	$0.68	$0.67	$0.67
Total of itemized costs per ewe	$9.25	$10.88	$10.05	$10.00

[a] Includes only those costs which differed between the two systems.

[b] Includes grain fed to the ewes plus grain fed to lambs per ewe exposed.

[c] Grain cost was 3.1 cents per pound.

[d] Hay cost was 2 cents per pound.

[e] Drenching cost was 17.5 cents per dose for ewes and 10 cents for lambs. Each ewe was given 3 doses of thiabendazole per year and each lamb was given one dose.

group consumed an average of 134 pounds of grain while lambs in the fall-breeding group consumed an average of only 10 pounds of grain.

Total grain consumption averaged 201 pounds per ewe exposed in the spring-bred flock and 68 pounds per ewe exposed in the fall flock. The average cost of the grain mixture was 3.1 cents per pound or $6.24 per ewe exposed in the spring-breeding flock and $2.11 per ewe exposed in the fall flock.

b. **Hay fed.** The spring-breeding group was fed an average of 355 pounds of hay per ewe exposed and the fall-breeding group was fed 361 pounds per ewe exposed. The hay was valued at $40.00 per ton. Thus, costs for hay were $7.10 and 7.22 per ewe exposed for the spring and fall groups, respectively.

c. **Drenching costs.** Three doses of thiabendazole were given each ewe each year. The average cost was 17.5 cents per dose or 53 cents per ewe per year. Lambs from the fall-breeding flock were given one dose each which cost 10 cents. Lambs from the spring-breeding flock were sold before any drenching was needed. Both flocks received identical phenothiazine-salt mixtures.

TABLE 5

Production of Lambs and Wool and Income Received from the Spring-Breeding Flock

	Year[a]			Average or Total
	1	2	3	
Ewes exposed	88[b]	84[b]	80[c]	252
Ewes lambed	57	64	54	175
Lambs born	92	106	74	272
Lambs died	8	12	9	29
Lambs available for sale	84	94	65	243
Average lamb weight at 150 days (lbs.)	77.9	83.3	84.4	81.7
Average price received for lambs (cents per pound)	26.42	29.18	31.21	29.00
Income per lamb	$20.58	$24.56	$26.34	$23.69
Lamb income per ewe exposed	$19.64	$27.48	$21.40	$22.82
Weight of wool per ewe (lbs.)	7.4	7.3	7.1	7.3
Price received for wool (cents per pound)	70.5	66.0	65.4	67.7
Income per ewe from wool[d]	$5.22	$4.82	$4.64	$4.94
Lamb and wool income per ewe exposed	$24.86	$32.30	$26.04	$27.76
Income less itemized costs	$9.86	$18.41	$13.40	$13.89

[a] Year 1 represents ewes exposed in the spring and lambing in the fall of 1963. Thus lambs from year 1 were sold in the spring of 1964, lambs from year 2 were sold in the spring of 1965, and lambs from year 3 were sold in the spring of 1966.

[b] One ewe died before the lambing season and is excluded from the analysis.

[c] Two ewes died before the lambing season and are excluded from the analysis.

[d] Does not include incentive payments.

Income. Income per ewe for the two systems, average weights of lambs available for sale per ewe, the weights of wool sold, and the prices received for lambs and wool are presented in Tables 5 and 6.

a. **Lambs available for sale and income.** The number of lambs available for sale was 1.45 per ewe exposed in the fall-bred flock and 0.96 per ewe exposed in the spring-bred flock. The average weights of lambs at 150 days of age were 87.0 pounds for lambs from fall breeding and 81.7 pounds for lambs from spring breeding.

The average price received for lambs from the spring-bred flock was 29.00 cents per pound and the price received for lambs from the fall-bred flock was 23.37 cents per pound. Thus, the income was $23.69 per lamb from the spring-breeding flock and $20.33 per lamb from the fall-breeding flock. However, due to the larger number of lambs produced per ewe exposed, income from lambs was higher per ewe exposed in the fall-breeding flock ($29.38) than in the spring-breeding flock ($22.82).

TABLE 6

Production of Lambs and Wool and Income Received from the Fall-Breeding Flock

	Year[a]			Average or Total
	1	2	3	
Ewes exposed	53[b]	43[c]	41[c]	137
Ewes lambed	46	38	38	122
Lambs born	85	69	68	222
Lambs died	8	5	11	24
Lambs available for sale	77	64	57	198
Average lamb weight at 150 days (lbs.)	85.3	91.6	84.3	87.0
Average price received for lamb (cents per pound)	21.80	24.98	23.55	23.37
Income per lamb	$18.60	$22.88	$19.85	$20.33
Lamb income per ewe exposed	$27.02	$34.05	$27.60	$29.38
Weight of wool per ewe (lbs.)	7.8	7.7	7.6	7.7
Price received for wool (cents per pound)	70.5	66.0	65.1	67.7
Income per ewe from wool[d]	$5.50	$5.08	$4.97	$5.21
Lamb and wool income per ewe exposed	$32.52	$39.13	$32.57	$34.59
Income less itemized costs	$23.27	$28.25	$22.52	$24.59

[a] Year 1 represents ewes exposed in the fall of 1963 and lambing in the spring of 1964. Thus lambs from year 1 were sold in the fall of 1964, lambs from year 2 were sold in the fall of 1965 and lambs from year 3 were sold in the fall of 1966.

[b] Two ewes died before the lambing season and are excluded from the analysis.

[c] One ewe died before the lambing season and is excluded from the analysis.

[d] Does not include incentive payments.

b. **Wool weights and income.** The average weight of wool per ewe exposed was 7.7 pounds for the fall-breeding flock and 7.3 pounds for the spring-breeding flock. All wool from the two flocks was sold at the same price each year and the average price received was 67.7 cents per pound for the three years. Wool income per ewe exposed was $5.21 for the fall-breeding flock and $4.94 for the spring-breeding flock.

c. **Total income.** Total income per ewe exposed from the sale of lambs and wool was $34.59 for the fall-breeding flock and $27.76 for the spring-breeding flock. After deduction of the itemized costs the income per ewe exposed was higher in the control flock — bred in the fall — in all three years. The average difference was $10.70 and varied only slightly among years. Since other costs except pasture were essentially the same in both groups, it is concluded that, while both systems returned a profit, fall breeding was $10.70 per ewe more profitable. This difference was due mainly to the lesser grain costs and the greater lamb crop for the fall-bred flock. The latter resulted in large part from a higher occurrence of estrus and a higher lambing percentage in ewes exposed during the fall.

Discussion of Significant Findings

Three differences found in this study due to season of breeding are perhaps worthy of further comment — (1) occurrence of estrus, (2) percentage of lambs born per ewe lambing, and (3) wool weights. Differences in other variables were considered in relation to the literature in the preceding section.

Occurrence of estrus. Harper (1966) recently reviewed the literature on seasonal differences in the reproductive ability of the ewe. He concluded that the length of the breeding season varied with breed but that in most breeds, a period of lowered occurrence of estrus and lowered ovulation rate could be expected in the spring. Research has indicated that both light (Yeates, 1949) and temperature (Dutt and Bush, 1955) are important in determining seasonal differences in reproductive activity.

Occurrence of estrus in the spring in the present study might be expected to have been at a maximum for three reasons: (1) the ewes had been shorn just prior to introduction of the rams — a treatment found beneficial in earlier work by Warren et al. (1957) in Georgia; (2) the ewes were not lactating so that seasonal differences would not be accentuated by the effects of lactation anestrus; and (3) the rams were introduced only at the time of breeding. Thus, any benefits of introduction of the ram (Schinckel, 1954, and others) should also have been at a maximum if the ewes were sensitive to such an "ovulation-inducing" effect at this season.

The fact that a low incidence of occurrence of estrus was a major limiting factor in the present study indicates that one approach to consider in attempting to increase productivity in spring-exposed ewes is the use of hormonal agents to induce estrus and ovulation. Control of light or temperature usually would not be feasible from an economic standpoint. The present study did not attempt to use any of these approaches.

Lambing percentage. Although conception rates among ewes showing estrus did not indicate a seasonal difference in this study, the number of lambs born per ewe lambing was lower from spring breeding. This could have resulted from a lower ovulation rate or from a lower fertilization rate or a higher embryonic death rate in ewes with multiple ovulations.

If ovulation rate was lower in the spring, as was shown by Radford (1959), hormonal therapy is again indicated as a possible approach to improving spring breeding performance.

Wool weight. The observed decline in wool weight with increased prolificacy was expected, since it had been seen earlier by several workers (e.g., Slen and Whiting, 1956; Seebeck and Tribe, 1963). The greater wool weight in the fall-bred ewes (measured after adjustment for number of lambs born) may indicate that either the stress of summer gestation or the demands of a long fall and winter lactation reduces wool growth of the ewe. Shelton (1964 a) has shown that summer gestation may interfere with the wool follicle development of the unborn lamb. The wool loss in the present study, although of little economic significance under current marketing conditions, must be real, since both groups of ewes were shorn on the same day each year.

Other studies. Having demonstrated the superiority of the fall breeding season over the spring, it is of interest to consider differences due to breeding date within the fall season. For two years, Taylor (1966) studied a West Virginia ewe flock which was divided into two breeding groups. One group was exposed to rams beginning in September; the other was exposed in October, 35 days later. Conception rate and lambing percentage were nonsignificantly higher at the later breeding date. The lambs born from the October breeding took 21 days longer to reach a market weight of 85 pounds than the earlier lambs. Income per ewe was nearly equal in the two groups. Most studies have indicated that ovulation rate and conception rate increase as the fall season advances (Hulet and Foote, 1967) but these advantages must be weighed against seasonal variations in lamb prices in a given area.

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